Virtual mission and training areas at the Dutch Land Training Centre: interoperable by design

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Abstract — Over the past years, the Dutch Land Training Centre (LTC) has sought to build an in-house capability for its Simulation Centre to generate virtual mission and training areas. Re-use and interoperability have always been key policy guides in this process. The resulting capability hence is interoperable by design: virtual terrains are generated with the entire chain of military operations in mind, serving different kinds of simulators from individual level up to staff level. Previously at ITEC, we have presented on projects that helped design a work flow that suits the LTC needs. We have now arrived at the point where the LTC Simulation Centre has the capability in-house. It was successfully used to support the training mission in Lithuania. This ITEC, we describe the capability that has been put in place. The Lithuania case is used to illustrate the benefits that we have reached and the open issues that remain.

1 Introduction

The generation of virtual mission and training areas, often referred to as *terrain databases*, has historically been a task that is costly, time-consuming, labour-intensive and highly dependent of the target simulator system. Gradually, we have been moving away from that situation. Re-use and interoperability have become common characteristics for modelling capabilities that shall generate virtual representations of mission and training areas in short time. This is exactly what the Simulation Centre of the Dutch Land Training Centre (LTC) has been striving after over the past years.

2 Needs and bottlenecks

The LTC is in a position where the need for virtual mission and virtual training areas is clearly seen as one of the key aspects of exploiting the benefits of simulation technology for military operations. Serving mainly land operations related units, the LTC is dealing with demands from a variety of units, like infantry, manoeuvre, fire support, special forces, land-based air defence as well as their related staff functions.

For purpose, on time

The user need for terrain databases typically originates from the fact of a user preparing for a specific (live) training exercise or a specific mission. In both cases, we observe the following:

- Even when a certain terrain is used by multiple simulation users, each user will have its own purpose and thus specific needs in terms of areas of interest and need for detail and functionality.
- The simulation users - mostly occupied by the intensive practical preparations for their exercise or mission - have a tendency of coming in late, not to say last-minute, with these specific needs.

As the LTC is a service-oriented organization, these two facts induce the need for a capability that delivers 'for purpose, on time' virtual mission and training areas. The LTC needs to be able to:

- React quickly and adequate to user needs.
- Realize short turn-around times of terrain generation (days or weeks instead of months or years).

Limited resources, maximum efficiency

With the Netherlands Army being a relatively small entity, and limited availability of both funding as well as human resources as recurring bottlenecks, efficiency is key to success. The LTC therefore strives after a capability that adheres to the following objectives:

- Interoperability should be an intrinsic feature of the capability. Different simulation users, with different simulation systems and thus terrain database demands shall be served from a single work flow. This will enable LTC to more efficiently serve multiple users and at the same time it fits in the LTC vision that simulation should support the full chain of military operations, from lower level training up to higher level staff support. The capability shall be interoperable by design, through generation of correlated (to a required extent) terrain databases for all simulation systems acting within the chain of operations.

- The capability shall enable LTC to be more *in control* of the terrain database development process, to work as efficiently and quickly as possible towards user requirements. This need is comparable to the agile approach that is proposed in [3] to obtain shorter development times for terrain databases and more direct user impact on the end-result.

3 Technical solution

Over the past years, the LTC co-operated with TNO and RE-liON (see [1], [2]) to develop a database generation work flow that would put LTC in a position to provide 'for purpose, on time' terrain generation for its users.

End-to-end workflow

The provided solution covers the full end-to-end work flow (see Fig. 1) that starts from source data, works towards a dataset consisting of both geodata and content models and from that feeds the database generation system to generate the terrain databases for the target systems.

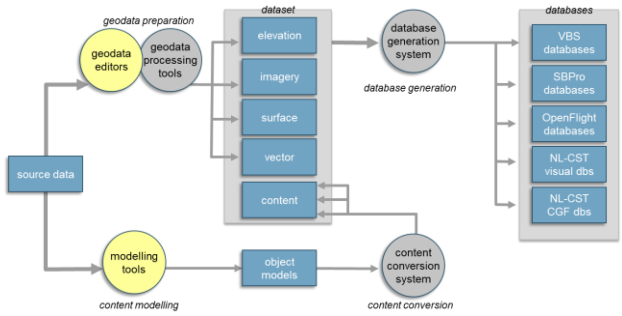

Fig. 1. Work flow schematic. Yellow processes involve manual interaction whereas the grey symbols indicate fully automated processing.

The database outputs as shown in Fig. 1 are the most frequently used systems: VBS for infantry simulation, SteelBeasts Pro (SBP) for manoeuvre simulation and the Dutch Command Staff Trainer system NL-CST. For further interoperable deployment, the OpenFlight format is generated. Other formats that can be generated include OpenSceneGraph and Unity.

Automatic where possible, manual where needed

The work flow strives after automatic processing where possible. The preparation of geodata is essentially done by starting a single script that transforms all source data, combined with manual edits, into a complete geodata set that is enriched and prepared for database generation.

The automatic geodata processing is partly done with ArcGIS (ESRI) through Python scripting. Next to that, many raster and vector transformations have been optimized for speed and functionality in C++ coded tools that are called from the scripts.

Manual interaction is provisioned for two purposes:

- Specific object models for high detail areas can be placed manually within a 3D what-you-see-is-what-you-get terrain editor.
- Manual editing of road, rail and waterway vector data can be integrated within the transformation of given source vector data.

Interoperable by design

The dataset is automatically transformed into the required terrain database targets. The commercial TerraTools (TerraSim) is used as a database generation tool for this purpose.

For the content models, an approach was developed that combines a dedicated building modelling approach using UrbanBuilder (RE-liON) with the more general-purpose approach of 3dsMax (Autodesk) as a modelling tool for objects other than buildings. The key characteristics of this approach are:

- All content models are automatically converted to all required target formats (i.e. p3d, DirectX, OpenFlight).
- Buildings can be modelled extremely quickly at a semantic level, without the need to model levels of details, damage models, navigation paths explicitly. Modelling effort is reduced from weeks to a few hours per building. Also, the resulting models can easily be extended to new target system features through software modifications, without the need to manually revise all models.

4 In-house capability

The complete work flow as described in the previous section has been developed by TNO and RE-liON and is now deployed in-house at the LTC in Amersfoort. It can be run by a team of LTC personnel that consists of:

- a small staff of technically trained employees that can operate GIS tools, modelling tools and database generation systems;
- a team of trainee employees that can operate the object and building modelling tools.

5 Results

During the development of the technical work flow, several virtual mission and training areas have been developed as use cases. The results of the in-house deployment can best be illustrated through the latest case that was handled, a virtual mission area for the Lithuanian training mission the Dutch Army is currently in.

A geodata set covering 440 km x 350 km was developed, covering the entire Lithuania country and parts of the adjoining countries. High detail elevation data (1 meter resolution) was combined with 1:10.000 scale vector data.

Buildings were represented using a set of 150 unique models typical for the Lithuanian region. The unique model count was kept low to accommodate the limitations of SBP, one of the main target systems. The models were automatically placed to match the available building footprint data as good as possible.

Image processing was applied to enrich the available vector source data with additional tree data, compensating for lack of vegetation data in the urban areas.

Fig. 2. SteelBeasts Pro screenshot for the Lithuanian terrain.

The scripting was setup by TNO. After deploying this to the LTC, the LTC was able to generate terrain databases based upon simulation user demands for specific exercises within a time frame of several days. In this way, successful exercises were run that use both the Command Staff Training system as well as SBP to combine staff level simulation with manoeuvre level simulation in a single setup, that was exploited for training and doctrine studies.

6 Discussion

With the workflow that was developed and deployed, LTC can be more in control of the process that seeks to provide 'for purpose, on time' interoperable terrain databases for simulation exercises and mission preparation. This is a significant step forward.

LTC can contribute to the content modelling and terrain editing process and can quickly generate any required databases per user request.

However, it is also observed that the actual database generation depends on the availability of a well prepared and enriched dataset. This still requires dedicated scripting and algorithm configuration or even development. As such, the generation of terrain database remains a process that needs highly skilled personnel capable of setting up the geodata processing.

Another aspect that offers opportunities for efficiency improvements is the management of getting a team of modellers working together on the geospecific modelling of a certain area. Dedicated tooling could help to assign the modelling jobs to the team and automatically provide relevant ground-truth photo and video material based upon geo-tagging of the material.

7 Conclusion

We have moved yet another step forward in the pursuit of rapid generation of virtual mission and training areas. Research has to be continued on how to find efficient approaches that bring sophisticated geodata processing to military users of simulation and provide these users full control over terrain database generation, for purpose, on time. Also, efficiency improvements are expected to be found in support tools that help organize the ground-truth source data and job assignment for the geospecific modelling of buildings and objects.

References

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Author biographies

Marco Welleman, mechanical engineer by training, started his career as a conscript in the Dutch army and quickly worked up through the ranks as reserve officer. After a period of working for civilian companies as an industrial 3D expert, he re-joined the military as a project manager for the Defence Material Organisation. During this time Marco gathered vast experience with several complex simulation systems. This enabled him in 2006 to focus completely on simulation, resulting in acquisition and rollout of the highly successful serious games VBS and Steel Beasts Pro for the Dutch army. Since 2008 he works for the Simulation Centre, division Land. In a joint function as advisor/project manager Marco oversees simulation components and content development.

Frido Kuijper has been affiliated to the Dutch research institute TNO since early nineties. Originating from the fields of computer graphics and high-performance computing, he is now a senior research scientist, focusing on innovations for automatic generation of virtual environment models for simulation. He has a broad experience in projects that served military with effective use of simulation technology in training and mission support.